

ALTERNATIVE COMPRESSION GARMENTS

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INTRODUCTION

Orthostatic intolerance after spaceflight is still an issue for astronauts as no in-flight countermeasure has been 100% effective. Future anti-gravity suits (AGS) may be similar to the Shuttle era inflatable AGS or may be a mechanical compression device like the Russian Kentavr. We have evaluated the above garments as well as elastic, gradient compression garments of varying magnitude and determined that breast-high elastic compression garments may be a suitable replacement to the current AGS. This new garment should be more comfortable than the AGS, easy to don and doff, and as effective a countermeasure to orthostatic intolerance. Furthermore, these new compression garments could be worn for several days after space flight as necessary if symptoms persisted. We conducted two studies to evaluate elastic, gradient compression garments. The purpose of these studies was to evaluate the comfort and efficacy of an alternative compression garment (ACG) immediately after actual space flight and 6° head-down tilt bed rest as a model of space flight, and to determine if they would impact recovery if worn for up to three days after bed rest.

METHODS

Eight astronauts participated in the space flight study and ten of sixteen volunteers have completed the bed rest portion of this study. All subjects were individually fitted for a three-piece, abdomen-high compression garment which provided 55 mmHg compression at the ankle that decreased to approximately 20 mmHg at the top of the leg and ~15 mmHg over the abdomen.

Space flight subjects were tested 10 days before launch (w/o ACG) and ~4 hours after landing (w/ ACG). Heart rate (HR), blood pressure (BP) and stroke volume (SV) were measured during 2 minutes of prone rest and for 3 minutes during standing. These results were compared to 8 control subjects (without countermeasures) who underwent a similar protocol in NASA's Functional Task Test "Recovery From Fall / Stand Test."

Bed rest subjects participated in tilt testing 5 days before (BR-5), after 14 days of 6° head-down tilt (BR+0), and after three days of ambulatory recovery (BR+3). Neither group of subjects wore garments during testing on BR-5 (similar to the flight study). All subjects donned the full ACG on the morning of BR+0 and wore the garments through the end of testing. Control subjects did not wear garments after testing on BR+0, but treatment subjects wore ACG until 10 PM on BR+0. Treatment subjects also wore reduced compression thigh-high garments the next day (BR+1) and further reduced thigh-high garments on the following day (BR+2). Bed rest testing consisted of resting echocardiogram, plasma volume (PV) measurement, and HR, BP and SV during 5 minutes of supine posture followed by 80° head-up tilt for up to 15 minutes on BR-5, +0, +1 and +3. PV was also measured on BR+2. Data are presented as mean \pm SEM.

RESULTS

ACG was effective in preventing signs and symptoms of orthostatic intolerance after both space flight and bed rest. After flight, Δ HR (upright average minus prone average) in the control group was elevated compared to pre-flight (pre: 15 ± 2 ; post: 21 ± 4 bpm) while there was no change in the ACG group (pre: 13 ± 2 ; post: 11 ± 1 bpm). Before bed rest, 2 of 10 subjects were presyncopal, while no subjects were presyncopal after bed rest using ACG. Compared to pre-bed rest, Δ HR was not elevated after bed rest (BR-5: 21 ± 7 ; BR+0: 14 ± 4 bpm). Control subjects demonstrated a marginal PV decrease after bed rest, but showed typical recovery the day after bed rest (BR+0: 2.32 ± 0.15 ; BR+1: 2.79 ± 0.15 L). Treatment subjects did not recover PV the day after bed rest (BR+0: 2.61 ± 0.23 ; BR+1: 2.61 ± 0.23 L).

CONCLUSION

Breast-high, elastic, gradient compression garments are effective in preventing post-space flight and post-bed rest orthostatic intolerance. However, use of these garments on BR+0 may prevent recovery of PV. Modified garments with reduced compression may be necessary to prevent prolonged recovery.